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Norwegian Deep Sea Mining: A New Frontier

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A case study in the Deep Sea rush for critical minerals

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Table of Contents

Executive Summary

Luc Parrot

The Norwegian Deep Sea Mining (DSM hereon) project is certainly one to keep an eye on. It serves and will continue to serve as the principal case study for all types of DSM, all over the world. This report examines the distinct but interlinked issues faced by DSM in Norway, from its initial demand due to the green transition to the various socio-economic and environmental impacts of such a project. Its overall purpose is to serve as a case study for this type of resource extraction, as humanity stretches the boundaries into the world's periphery.

Key Findings

- Norway is attempting to become a pioneer in DSM with an ambitious commercialisation of its continental shelf.
- For western economies, DSM is an appealing solution to the critical minerals crunch caused by the green transition and 'de-risking' away from China.
- There are no direct analogies to Norway's project, but useful parallels worldwide.
- In technical, political, and legal terms the DSM project is feasible, yet with numerous caveats that make its economic viability uncertain.
- Economic impacts in Norway are likely to be dispersed across several industries, with indirect benefits such as infrastructural development.
- Internationally, this would mean a new competitor in the market of critical minerals and potential territorial disputes.
- Environmental impacts remain uncertain, with several institutions and governments calling for moratoriums on all DSM.
- Domestic political and societal opposition threatens the approval of Norway's DSM, although the project is slowly advancing.
- At this infant stage DSM remains an uncertain endeavour, with variance in local conditions clouding the possibility of replicating the Norwegian project elsewhere.

Overview of DSM in Norway

Sasha Takeuchi

Norway announced on the 20th of June 2023 that it is proposing to open up a part of its continental shelf about the size of Germany with an estimated reserve of 38 million tonnes of copper among other metals for commercial DSM. Furthermore, the country presented a strategy for seabed mineral resource management as it aspires to become a global leader in the field. This decision is based on the earlier Seabed Minerals Act of 2019, and this DSM project has been in an extensive process of reports, recommendations, and consultations since 2020. The Norwegian government extols the project's potential for the Norwegian economy tying in with established experience in marine science and operations, making it the *perfect* actor.

The main imperative driving this move is the green transition. Accordingly, critical minerals will unavoidably become more in-demand and subsequently crucial to reduce the impact of ongoing climate change and environmental degradation. As such, two powerful dynamics are underlying this endeavour: resource security and environmental protection. Indeed, the anticipated DSM is a "new frontier" that would provide greater independence from the minerals production quasi-monopoly of China which accounts for 50 to 70 percent of the lithium and cobalt and as high as 90 percent of rare earth elements of the world total processing, some minerals that are now considered "critical" in places such as the E.U. or the U.S.A. Recommendation for resource security strengthening through innovative primary extraction in face of the Chinese supply domination concern is a tendency that has also been observed in other places including the U.K. for the last decade.

While the target is ambitious, it is still quite unclear how the government intends to set the delicate equilibrium between nature exploitation and conservation. It adopts a "precautionary approach" (transl.) but nonetheless advocates for a "rational exploration" (transl.) in its white paper on DSM. In fact, the precautionary principle too often based on a mere hazard classification is quite incompatible with a scientific risk assessment based on probability as it was pointed out in controversial public health decisions. As a matter of fact, it must be expected from Norway that it follows an evidence-based, fair, and predictable approach to the precautionary principle.

This report aims to give a synthetic and up to date insight into the Norwegian DSM project in the broader context of DSM being increasingly used as a reliable future strategy. The interest in seabed mining will first be remembered. The skyrocketing demand for and the fragile offer of minerals on the international market is a looming threat which is getting more real by the day. A first section therefore presents the foundations on which this trend is developing. Thereafter, an overview of past attempts in similar situations is exposed. In a third section, the feasibility in economic, technical, and political terms are examined. In a fourth section, the

economic, environmental, and political possible impacts are analysed. In a final section, we deliver some projections on the timing as well as the evolution of the practice among other countries in a broader context.

A Needs-Based Context

Luc Parrot

Resource economists often state that 'new demand creates new reserves'. In the case of the minerals needed for the wider green transition and EV battery production such as lithium, nickel, and cobalt among others, the ever growing demand is evident. As such, new frontiers are sought to fulfil growing needs- exemplified here by Norway looking to their seabed.

Strong interest in DSM is driven by a push for commodities crucial to the green transition and the search for 'net-zero'. As western states set deadlines for the ban of cars with combustion engines, industrial bases are shifting to producing electric vehicles. This entails the shaping of new supply chains to secure minerals such as lithium, cobalt, and nickel. DSM presents potential large amounts of these very materials. The EU recently cautioned that supply squeezes from imported raw materials could threaten its goal of net-zero emissions by 2050. Accompanying these industrial demand increases is growing media presence, with the owner of UK Seabed Resources in the Financial Times recently warning that "Europe must be prepared to support DSM… to secure materials crucial to making the transition". At the same time, anticipated demand from some key industry stakeholders such as carmakers is far from certain. Companies such as BMW and Volvo, in addition to technology company Samsung, have all pledged not to use minerals coming from DSM due to environmental concerns.

There is a broader pressure on mineral resources that goes beyond simply demand due to EV battery production. Most notably, Western economies are seeking to 'de-risk' from Russia and especially China, which holds a dominant market position in refining certain Rare Earth Elements or cobalt. In view of Russia's invasion of Ukraine and repeated trade spats with China, Western economies are waking up to the fact that previous and current supply chains may not be so secure in the future. The use of these minerals in certain weapons systems present clear national security implications for western armies. Finding a reliable source of critical minerals in Norway, a member of NATO and the European Economic Area (EEA), means supply chains are more resistant to shocks and less vulnerable to outside influence.

In relation to land-based mining, DSM is proving its advantages. An industry that has long been plagued by various issues such as deforestation, child labour, and community opposition now sees a potential competitor. Land-based projects also face lengthy waits for permits, while DSM permits are being explored in ever greater detail worldwide which could lead to future streamlining of the permit process. The resource limits of land-based minerals can also be

bypassed by DSM. The International Energy Agency estimates that 80 million tonnes of nickel has to be mined in the next 20 years for the world to hit its climate targets, more than has ever been mined until this point. This points yet again to looking at the potential benefits of DSM. Yet such comparisons must also remain realistic to the costs of potential DSM projects. Should land-based mining remain more profitable, it would be unlikely to see large shifts towards DSM sourcing.

Amongst the various strands of demand pushes and supply crunches, the causal chain between increased pressure on critical metals leading to an interest in DSM is undeniable.

Global Parallels

Sasha Takeuchi

There are no directly analogous examples to draw on when discussing DSM in Norway. However, there are useful cases where parallels can be identified.

Several attempts to mine deep sea mineral resources have been made up until now. *Solwara 1* is the world's first announced DSM project. It is to take place in the Papua New Guinean EEZ, under the Bismarck Sea. The target is seafloor massive sulfide deposits on a surface area of about 0.112km² at 1,550 metres depth capable of delivering approximately 1.2 to 1.6 million tonnes of minerals per year. Nautilus Minerals, a Canadian company headquartered in Australia, had the mining lease from 2011 until it ceased its activities after going bankrupt in 2019. While very supportive at the beginning through granting sizeable funding, the government of Papua New Guinea has often changed its position on the matter. When the company collapsed, the project was called a "total failure" by the prime minister who supported a decade-long moratorium on DSM. Besides, due to stark community opposition, legal issues, and constant financial obstacles, the project has since its inception been being contentious and slowed down. Nevertheless, the government has recently been reported to be pursuing talks on *Solwara 1* with the acquiring of the Canadian company Deep Sea Mining Finance.

A more recent effort led by the Japan Oil, Gas and Metals National Corporation (JOGMEC) off the coast of Okinawa in Japan became the first ever "large-scale" DSM with effective extraction in 2017 within national jurisdiction. It succeeded in extracting minerals at 1,600 metres depth in a deposit with an estimated amount equivalent to the national Japanese zinc consumption. It later achieved another feat by excavating 649 kilos of CFC near Minami-Tori Island on a deposit expected to meet the domestic demand of minerals such as cobalt for several decades. This latter endeavour is embedded in a clear move towards greater independence from the Chinese mineral supply domination following Japan's new "National Security Strategy". In that regard, rare earth elements have thus been categorised as one of the 11 "specified critical

materials". Reportedly, the country is expecting to start intensive DSM in 2024 especially for producing the essential parts of Electric Vehicles.

DSM activities are also noticeably being conducted in other states such as India, China, the Cook Islands, and the U.S.A.

Feasibility:

1. Economic

Julia Pollo

The economic feasibility of DSM in the Norwegian Sea for critical minerals depends on several factors. As demand increases, traditional sources of these minerals become scarce, increasing the interest in areas that are harder to access even with challenges to make the operation economically viable. It is important to acknowledge information regarding the project's financing have not been publicly displayed, making it more challenging to properly access.

The first consideration that needs to be made is the quantity of critical minerals accessible, as a substantial concentration is essential to establish economic viability of mining operations. A study undertaken by the Norwegian Petroleum Directorate (NPD) has shown that substantial amounts have been found in the region. Notably, this includes magnesium, niobium and cobalt, all of which are included in the European Commission's list of critical minerals. Some estimates project a significant deposit, including 38 million tonnes of copper- a quantity nearly twice the annual global extraction- and an equivalent 45 million tonnes of zinc, both situated at great ocean depths. It is likely that this amount of minerals will make the operation economically viable as a long term investment. However, several unexpected factors, such as technological challenges and market demand can impact total revenue.

Deep seabed mining is technologically complex and requires specialised equipment and techniques, which will also imply a significant cost factor. Additionally, harsh environmental conditions of the deep sea such as high pressures, extreme temperatures, lack of sunlight and corrosion can pose operational challenges if feasibility studies are not fully conducted. Various types of equipment are used for deep sea exploration, such as remotely operated vehicles (ROVs) and autonomous underwater vehicles (AUVs). Technological feasibility is further explored in next of this report, however, it is important to mention that it can largely affect the economic return of the operation.

Regulatory conditions, also detailed in the legal feasibility section of this report can also impose economic challenges. Environmental and international legal issues, both cited in the Olje-OG Energiedepartement report, can increase the overall project cost. However, the economic feasibility of DSM crucially relies on the demand for critical minerals and, consequently, their market prices. According to the same report, the use of copper has tripled in the last decade, and is expected to increase even more, both due to technology products and renewable energy grids. In this case, the mining can be seen as a long term investment, considering that the price of the assets is very likely to increase. Copper demand is expected to increase between 275 and 350% by 2050 and could be traded as $10,756 a tonne by 2030.

2. Technical

Luc Parrot

On a technical level DSM certainly presents fairly unique challenges. High pressure, a lack of sunlight, and low temperatures on the seabed complicate attempts to extract metals. Different methods depending on the type of mineral deposits are used. Yet key technological milestones have recently been met in view of commercialising DSM.

Firms and governments are particularly interested in deposits of polymetallic nodules, which are scattered minerals of various types grouped together. These contain traces of copper, cobalt, nickel, manganese, and rare earth elements. Finding these specific metals is promising due to their land-based extraction being linked with deforestation, forced labour, and displaced communities. Of the ways to extract metals from the seabed this is the most straightforward and involves underwater dredging machines being driven on the seafloor and sucking nodules through a tube to a ship at surface-level (see *Figure 1* for a visual representation). This is therefore the primary focus of the fledgling DSM industry and is expected to be the main method should DSM commercialise on a large scale.

Other types of deposits, such as sulphides formed around hydrothermal vents similar to hot springs or the metal-rich crusts located on seamounts have greater technical difficulties facing their access. The need for cutters before collection and more specialised equipment based on varying local conditions means more expensive equipment, both to develop or purchase.

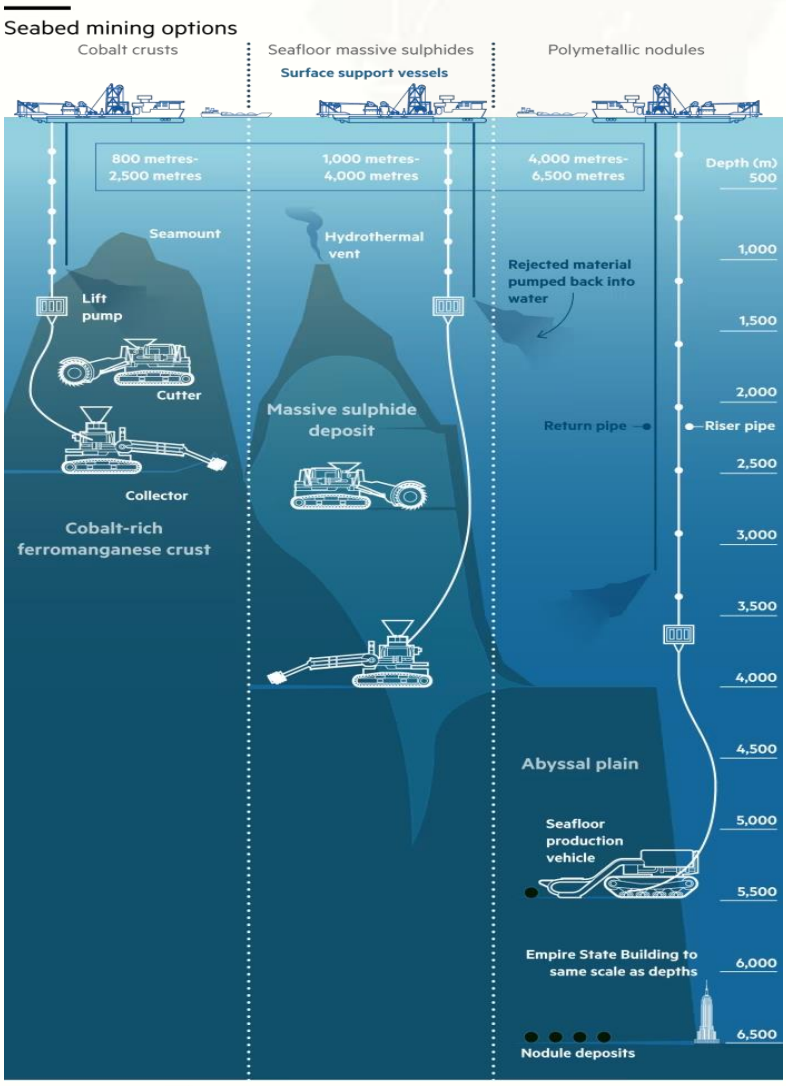

Figure 1: Visual representation of technical methods to DSM, 25 April 2023, Source: Financial Times

Figure 1 shows the three DSM methods depending on mineral deposit type. While polymetallic nodules may often be the deepest option, it is a less capital-intensive process when compared to the other two types of deposits. In absolute terms every type of DSM has high capital expenditure, so investments are largely made into the technology deemed the most likely to be profitable- in this case polymetallic nodules. Because of this clear preference for one type, the technical barriers to DSM are close to being vanquished. The various other factors explored by this report such as legal or environmental concerns are more likely to hinder DSM.

3. Legal & Political

Sasha Takeuchi

The area Norway intends to open up to DSM lies on its continental shelf (i.e., beyond 200 and up to 350 nautical miles from land). As this DSM project is planned to take place within

Norway's jurisdiction, it has an exclusive right for exploration and exploitation under the provision of the UNCLOS, a set of UN maritime laws.

However, there is only one place which is contentious: the Svalbard archipelago. Indeed, the Svalbard (formerly known as Spitzbergen) Treaty signed in 1920 recognises Norway's sovereignty over the Svalbard archipelago and all islands between latitudes 74° and 81° North and longitudes 10° and 35° East. All signatories' citizens and companies enjoy equal access to and residency rights in Svalbard. Furthermore, they are all permitted to fish, hunt or engage in any type of maritime, industrial, mining, or commercial activity on an equal basis on land as well as in the territorial waters. There may not be preferential treatment based on nationality, but all activity is governed by laws enacted by Norwegian authorities. Norway has the obligation to preserve Svalbard's natural environment and must make sure that no forts or naval bases are built there. As of now, the Svalbard (Spitzbergen) Treaty has 39 parties registered. There are some disagreements especially on the geographic scope of the treaty. This issue has often been actualised due to the coveted valuable resources located there: firstly, in the 1960's and 1970's regarding fishery and petroleum, and more recently, regarding snow crab and seabed minerals. As a matter of fact, Norway has regularly been at odds with the other parties when it comes to the interpretation of the treaty, most notably with the USSR and then Russia and the E.U. through its members. Some, including Norway, have a restrictive reading and argue that the treaty does not apply beyond the territorial waters, 12 nautical miles from the coast, especially knowing that it predates the UNCLOS. Conversely, others have an extensive reading and argue that the treaty shall apply beyond the territorial waters and thus comprise the surrounding zones including the continental shelf in accordance with the UNCLOS. There continues to be quite significant legal discussions on the matter. Opinions diverge without a clear consensus. Even after posing different criteria such as the wording, object, purpose, and similar cases, an unequivocal conclusion could not emerge.

Notwithstanding, this territorial dispute recently culminated in the snow crab catching case opposing Latvia to Norway. The Norwegian supreme court ruled in favour of Norway confirming the strictest sense interpretation of the treaty, thereby consolidating the country's claim for exclusive authority on surrounding water beyond 12 nautical miles from the islands. This is becoming a burning issue as the geopolitical context in Europe is now extremely tense and polarised following the onset of the Russo-Ukrainian War in 2022. Despite the Arctic Five (U.S.A., Russia, Norway, Denmark, and Canada) countries being committed to use the legal framework created by the UNCLOS to resolve any overlapping claims as agreed in the Ilulissat Declaration, the fact that Svalbard is an exception to the Law of the Sea does not bode well. The contested status appears to be a serious threat for regional stability in light of the intensifying strategic and resources stakes especially since the start of the war in Ukraine and most alarmingly with the aggressive Arctic behaviour of the Russian Federation. More recently, several publications from the CSIS as well as LP stressed the issues of the archipelago. What both countries peacefully achieved in 2010 with the boundary and cooperation agreement in the Barents Sea and Arctic Ocean could soon sound like an old story. Therefore, the DSM

project in the current state is most likely feasible in all the areas Norway has jurisdiction in, that is the EEZ and the continental shelf, with the notable exception of the area around the Svalbard archipelago. Indeed, undertaking this project under the waters surrounding these islands can involve a non-neglectable level of risk due to the tensions between Russia and the West as well as NATO, which Norway is a member of.

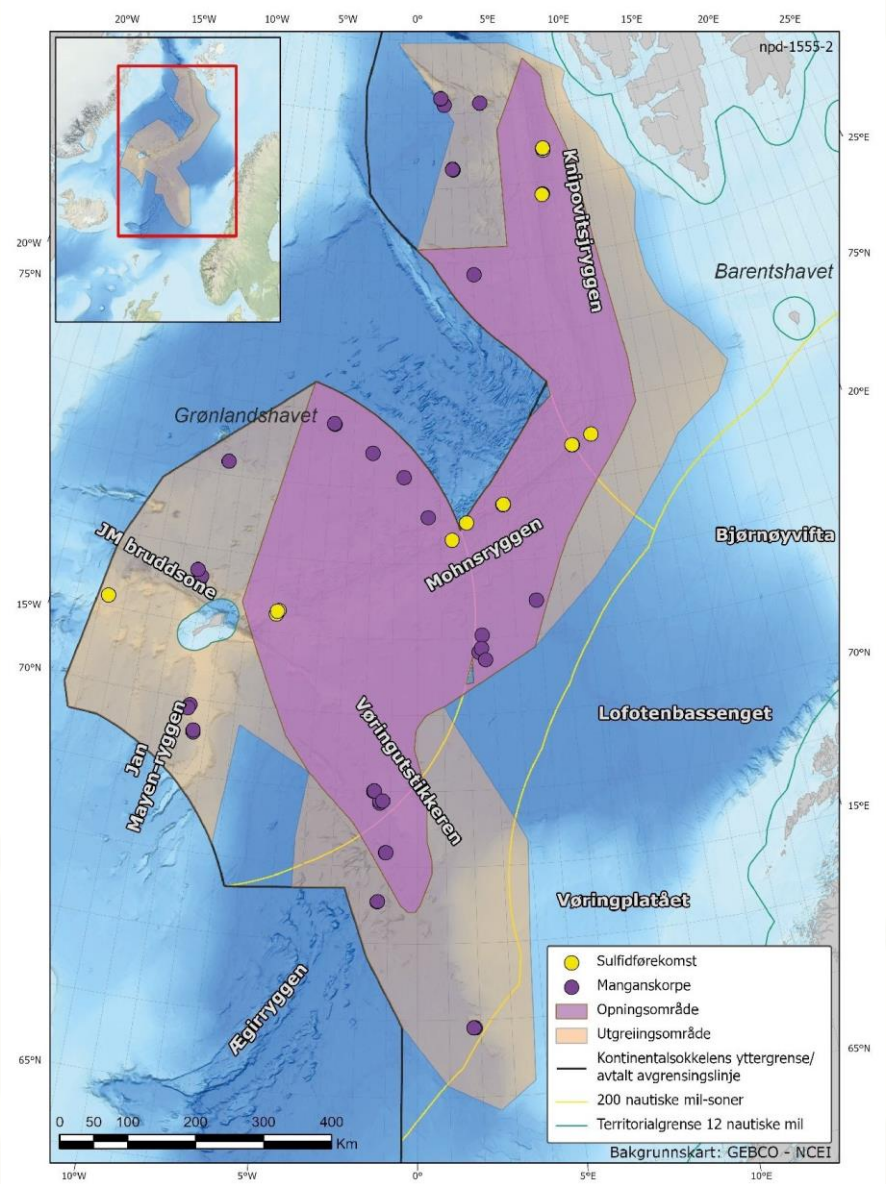

Figure 2: Map showing the areas of interest for DSM in Norwegian waters, 20 June 2023. Source: Olje- og energidepartementet, p. 22
Transl. note: the purple zone is for opening-up mining and the orange zone is for exploration

Impact:

1. Economic

Julia Pollo

The Norwegian seabed mining is an extensive and innovative project, thus, its economic results are likely to have a great impact on government, business, and financial markets. Besides the income generated with the rising price of critical minerals related to their increasing demand, the project will also have other positive impacts for the Norwegian economy. This is highly dependent, however, on the profitability of the resources found in the region. As with other parts of this analysis, there is great uncertainty around specifics - as data such as cost of operation, time, and price of materials are not fully established or released to the public. Moreover, due to the innovative nature of the project, there is little benchmarking that can be made in order to gather similar information.

The extensive white paper released by the government, "Mineral activities on the Norwegian continental shelf - opening of acreage and strategy for resource management", also states the commercial and macroeconomics impacts that can follow after the Norwegian DSM project. Successful seabed mining operations can be beneficial in economic aspects, leading to windfall revenues to the Norwegian government and companies involved in the operation. This revenue can boost the country's budget, leading to public spending on several areas - infrastructure, education, research, health - that also bring valuable return to the government, contributing to GDP growth in a similar manner to Norway's current oil and gas exploitation. This development is also strongly associated with infrastructure development, from newly developed ports and transportation networks, to shipbuilding industries, which will likely compound positive impacts.

Moreover, as mentioned in the report, the industrialisation of seabed critical minerals will be a value chain. In this case, as domestic industry grows in several fields including engineering, geology, logistics, marine biology, the sea bed mining industry will create employment opportunities, which increases employment rates, leading to increased tax revenue, lower government expenditure and, overall, economic growth.

As for the international framework, the trade balance can be affected. The Norwegian trade balance has been in surplus since 1989 and, if the country becomes an important exporter of critical minerals, this surplus could further improve leading to a more favourable economic position vis-a-vis trading partners such as other European Economic Area states.

Other international macroeconomics aspects should also be taken into account, including the repercussions on neighbouring countries and in other nations that are also significant players

in the production and mining of critical minerals such as the United States, China, Australia and Chile. However, as mentioned before, the uncertainty in several details of this project makes it difficult to fully assess the likelihood of these events occurring.

2. Environmental

Julia Pollo

The environmental impact related to this project is somewhat unknown. While some try to highlight the positive aspect of mining minerals for producing electric batteries, others call attention to the unknown environmental impacts related to such an expensive operation.

On the positive side, Norway's seabed mining has the main purpose of obtaining minerals that can later be transformed into EV batteries, which is good for the environment for several reasons such as reduced greenhouse gas emissions, lower carbon footprint, and higher energy efficiency. In the longer term, transitioning to renewable energy sources is crucial for addressing the environmental challenges of the future. Regarding this specific project, Jonas Gahr Støre, Norway's prime minister, has stated that subsea mining can be conducted without impact on ocean life. Yet more than 700 scientists and international NGOs have come public to highlight how deepsea mining can result in the loss of marine biodiversity and degradation of ecosystems, especially in the Norwegian Arctic, an ecosystem already impacted by climate change and without clear information of what the extent of impacts could be.

Furthermore, environmental groups also argue that the limited understanding of deep sea mining's consequences prevents comprehensive evaluation of its impact. They state that extracting minerals from the ocean floor may lead to rapid and irreversible destruction of both identified and undiscovered specie's habitats. Recently, researchers discovered over 5,000 species in the Pacific's deepsea regions, underscoring the rich biodiversity that could be at risk if deepsea mining proceeds without proper consideration of its potential effects. Professor Lise Øvreås states that "The seabeds have taken thousand of years to form, and the damage will be irreparable similar timescales".

The rising demand for rare minerals can repeat this scenario in several other countries, a topic further detailed in other sections of this report. While the International Seabed Authority (ISA) could authorise industrial developments to a greater extent, the European Academy of Sciences warned of the catastrophic possible consequences and called for a moratorium on DSM along with Germany, Switzerland, or Brazil. The organisation suggests that there are other practices, less harmful to the environment, that can be used and enhanced before resorting to these measures. Improvements in mineral recycling rates and current onshore deposits could be sufficient in the short-term to supply growing demands.

The question of whether the benefits outweigh the drawbacks still needs thorough evaluation. While the adoption of renewable energy is highly beneficial for the environment due to its positive impact on reducing greenhouse gas emissions and promoting sustainability, the growing demand for rare minerals also raises concerns about the potential consequences of DSM. These minerals are essential for various technologies, leading to a rising demand. However, there are less harmful alternatives that can be employed first, such as improved recycling methods. For now, the issue seems a double-edged sword, and determining the environmental impact remains challenging as it is still a largely unexplored territory, requiring future research and evidence based policy-making.

3. On International Politics

Sasha Takeuchi

First and foremost, understanding the conceptual implications of this endeavour is crucial. This speaks to recent human vertical capabilities now stretching to the confines of the oceans and the solar system, consequently giving the rise here to a new "geopolitical" scene. The latest intellectual progress on the concept of territory perhaps offers fertile insights. According to scholar Elden, territory is to be understood as a process, a "political technology" in the broad sense, which is about "techniques for measuring land and controlling terrain". It is a volume (i.e., three-dimensional) being made by "geo-metrics" which are being exerted. Therefore, DSM with all the machinery it involves in an unambiguously volumetric space is also a sound example of *territorialisation*.

Furthermore, the question of resources which is at the centre in DSM is intimately connected to the one of territory. Indeed, it is argued that gaining resource security is consubstantial to *territorialisation*. The underwater space can be thought of as a subsurface prolongation of terrestrial volumes that goes side by side with the gradual logics of political territoriality, even if the extension of sovereign rights and territorial sovereignty must not be confused. In other words, penetrating this deep sea volume with the subsequent possible rights such as access, property, exploration, or exploitation should be seen as the first move towards territorial "arrogation" irrespective of the extent to which claims for sovereignty truly go. As a consequence, the Norwegian DSM has the capability to effectively strengthen the geopolitical grasp of Norway on the surrounding seas of Svalbard. This is consistent with the Kingdom's position on that area and thus complements its political rhetoric.

As of regional geopolitics and international relations, the reshuffle of the priorities on the international stage imposed by the Russo-Ukrainian War should spare Norway from any allied countries' severe backlash, such as the U.K. and the E.U. member states. Yet, pollution and access concerns have already been raised respectively by British and Latvian fishery

companies. On the latter, the Kingdom has adamantly opposed. Yet, these protests have not been followed by substantial reactions from concerned countries. In fact, the main risk remains a negative reaction from Russia, which still asserts rights on the continental shelf around Svalbard. Even if the fear of an invasion would be exaggerated, as Dr. Buchanan told to *Mining Technology* in June 2023, "traditional access rights and activities of Russia in Svalbard […] have become murky… clouding the activities of Russian forces and interest to Svalbard, and planting the seed in Western threat perceptions that an enhanced Russian posture or interest in Svalbard is going to precede a Russian 'annexation' of the archipelago"; Svalbard is becoming "increasingly geopolitically significant".

4. On Domestic Politics

Julia Pollo

Aside from the international criticism, the project is facing opposition from political parties and parts of the Norwegian population. The Labor Party, represented by the Prime Minister Jonas Gahr Støre since 2021, has proposed to follow with the seabed mining project, and therefore, it is expected that fellow members of the same party follow this initiative. Terje Aasland, also a member of the Labor Party, and the current Oil and Energy Minister stated that the minerals that will be reached with this project are structural to the green transition to succeed, opposing the idea that Norway could lose its international "green" image if the mining follows through.

As expected, members of divergent parties posed great opposition, claiming that the mining could threaten biodiversity and fragile ecosystems. Ola Elvestuen, the environmental representative for the Liberal Party, went public to advertise the risks related to the project. Although there is a clear role of critical minerals in clean energy transitions, Elvestuen claimed that there is no specific need for these minerals to come from the seabed mining.

While the debate over seabed mining in the Norway Parliament is expected to take place in the coming months, certain indicators can be drawn from past statements. The centre-left coalition will require the opposition's support to approve the project. The Liberal party has been vocal in their resistance to the project, expressing likely reservation. On the other hand, the Conservatives, who initiated a similar process during their previous term in power indicated a willingness to consider support the project, offering a rare show of assistance. Apart from environmentalists who have voiced concerns about the potential and unknown impacts of this project, opposition may also arise from representatives of specific segments of society. Fishing operators, heavily reliant on the waters surrounding the project area, could also express opposition to the proposed initiative.

Projected Trends

Julia Pollo

If Norway can successfully engage in this project, and demonstrate the requisite economic, technical and political feasibility, it can become the first country to engage in extensive seafloor mining, opening the path for others to follow. With increasing demand for critical minerals that can produce EV batteries, it is expected that countries push to more extreme and unconventional possibilities in order to obtain this kind of resource. However, the pace and extent of such developments would likely vary from country to country based on unique circumstances.

This scenario also increases support for the Norwegian initiative. Troy Bouffard, director of the Center for Arctic Security and Resilience at University of Alaska Fairbanks claimed that "such activities are going to happen anyhow, and Norway is the right nation to demonstrate how to do it right". The country has responsibly exploited natural resources in the past, for example with the offshore oil production that peaked in 2001.

The potential of more countries following Norway's path into seabed mining would rely on how other nations perceive the economic and strategic benefits versus the environmental risks and uncertainties associated with DSM explored in this report. Moreover, the adoption of DSM practices on a global scale is subject to complex geopolitical, environmental and regulatory considerations. As embracing renewable energy also promotes energy security, reducing dependence on foreign oil and enhancing economic stability, the exploration of seabed minerals can also raise geopolitical competition among nations with maritime interests.

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